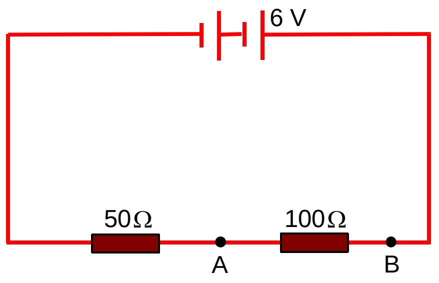
TAP 118- 2: Tapping off a potential difference



A series circuit is connected as shown in the diagram.

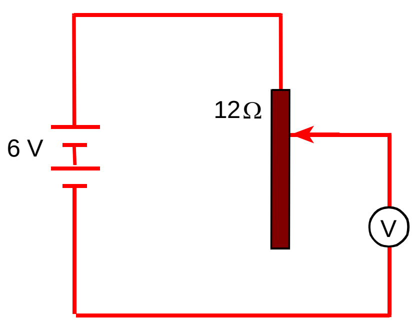
1. What is the potential difference between A and B?

2. An additional resistor of 100 Ω is connected between the 50 Ω resistor and the cells. What is the potential difference between A and B now?

3. The additional 100 Ω resistor is now connected in parallel with the first 100 Ω resistor. What is the potential difference between A and B now?

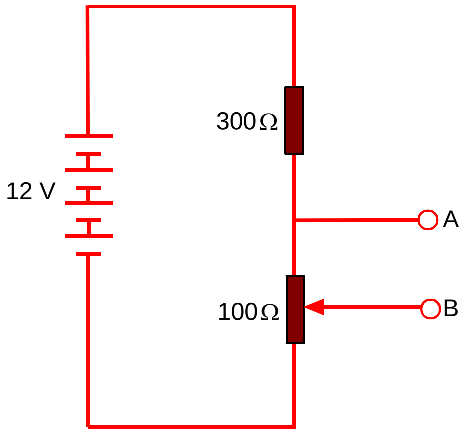
4. A potential divider is made from a 4 kΩ and a 6 kΩ resistor connected in series with a 20 V supply. Draw a diagram of the arrangement. What four values of potential difference can be tapped off?

5. A student puts a 12 Ω variable resistor in series with a 6 V battery, expecting to get a variable potential difference.



The voltmeter is a high resistance digital multimeter. Explain why the circuit won't work. Draw a circuit which would work.

6. B is the wiper of a 100 Ω rotary potentiometer.



What is the full range of the potential difference that can be tapped off between A and B?

Hints

1. Resistors are in the ratio 50 :100 so the potential difference splits up 1 : 2.

3. Work out the equivalent resistance of the two 100 Ω resistors in parallel first.

6. Find the pd set up across the potentiometer first by looking at the ratio of the resistors.

Answers and worked solutions

1. 100 Ω / (50 Ω + 100 Ω) x 6 V = 4 V

2. 100 Ω / (50 Ω + 100 Ω + 100 Ω) x 6 V = 2.4 V

3. Resistance of parallel combination = 50 Ω. So the 6 V supply potential difference splits equally between the two 50 Ω and pd across AB is 3 V.

4. Resistance of whole potential divider is 10 kW

$$\text{p.d. across } 4\text{ k}\Omega = \frac{4\text{ k}\Omega}{10\text{ k}\Omega} \times 20\text{ V} = 8\text{ V}$$

$$\text{p.d. across } 6\text{ k}\Omega = \frac{6\text{ k}\Omega}{10\text{ k}\Omega} \times 20\text{ V} = 12\text{ V}$$

$$\text{p.d. across } 10\text{ k}\Omega = \frac{10\text{ k}\Omega}{10\text{ k}\Omega} \times 20\text{ V} = 20\text{ V}$$

5. The resistance has been connected as a variable resistor. The multimeter has an extremely high resistance so that wherever one moves the sliding contact the pd is set up across the voltmeter which always reads 6 V! The redrawn diagram should show the ends of the resistance connected across the battery

6. The resistance of whole potential divider is 400 Ω. The supply pd 12 V splits between the fixed 300 Ω resistor and the 100 Ω potentiometer in the ratio of their resistances. So there will be 9 V across 300 Ω and 3 V across 100 Ω.

   When the slide contact from B is next to A the pd tapped between A and B is 0 V; when the slide is at the other end of the potentiometer the full pd of 3 V is across AB.

External references

This activity is taken from Advancing Physics Chapter 2, 170S